

a³ 8. (Amended) The process of Claim 1, wherein said copper oxide is present after a chemical mechanical polishing (CMP) step.

a⁴ 28. (Amended) A process for producing an integrated circuit comprising the following steps, in order:

depositing a copper layer on a substrate;
subjecting the copper layer to a CMP process;
contacting the substrate with one or more vapor phase organic reducing agents; and
depositing an etch stop layer on the substrate, wherein the organic reducing agents comprise at least one functional group selected from the group consisting of alcohol (-OH), aldehyde (-CHO), and carboxylic acid (-COOH).

Remarks

Claims 1-17 and 28-32 are pending. Claim 29 has been cancelled and Claims 1, 5, 8 and 28 have been amended. The specific changes made to these claims are indicated on the attached page captioned **Version with Markings to Show Changes Made**. On that page additions are underlined and deletions are struck through. The amendments are fully supported by the specification as originally filed. Claims 5 and 8 were amended to correct typographical errors pointed out by the Examiner. Support for the amendments to Claim 28 is found at least at page 9, lines 1-6, page 10, lines 4-6 and in original claim 29.

Support for the amendment to Claim 1 can be found throughout the specification. One of skill in the art will recognize from the disclosure that the organic reducing agent is a stable molecule and is not an activated or ionized species. For example, the section titled "Preferred Reducing Agents" at pages 10-13 discusses organic molecules and does not refer to activated or ionized species. This is in contrast to the disclosure at page 13, lines 14-25, which discusses the use of activated species and is entitled "Alternative Reduction Chemistries." Additionally, the disclosure at page 9, lines 1-2 indicates that the organic reducing agent is vaporized prior to being provided to the reaction chamber. Thus, the organic reducing agent is clearly capable of being present in a non-vaporized state. One of skill in the art will recognize that once formed, a plasma discharge can not subsequently be vaporized prior to being provided to the reaction chamber. Further, at page 10, line 21, the specification indicates that preferred organic reducing

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agents are bulky molecules that react at the surface and do not diffuse downward through the copper oxide layer. Again, one of skill in the art will recognize that this disclosure refers to stable molecules and not ionized species.

Priority

Applicants thank the Examiner for pointing out the possible benefit of claiming priority under 35 U.S.C. §119 to a foreign application. While the present application is related to Finnish patent application number 20001163 and PCT FI01/00473, Applicant's do not wish to claim priority under 35 U.S.C. §119 at this time.

Information Disclosure Statement

The Examiner objected to the Information Disclosure Statement filed January 29, 2002 because some of the references have not been provided with dates in accordance with 37 CFR 1.98(b)(5). In particular, the Examiner did not consider reference numbers 15, 20, 21, 22, 24, 28, 29, 31, 33, 34 and 36.

37 CFR §1.98(b)(5) requires that a date must be provided for each publication. Applicants submit that the 1449 filed with the Information Disclosure Statement on January 29, 2002 indicated that each of references 20, 21, 22, 24, 28, 31, 33, 34 and 36 was published in 2000. Thus, Applicants submit that these references were appropriately described and request their consideration by the Examiner. No date was provided for references 15 and 29. For the purposes of Examination, the Examiner is requested to assume that these reference publications predate the filing date of the present application by more than one year. A new IDS listing the references that were not considered is submitted herewith.

Drawings

The Examiner objected to the drawings on various grounds. Corrected formal drawings are submitted herewith that are believed to overcome the Examiner's objections.

Claim Objections

The Examiner objected to Claim 5 and Claim 8 as containing typographical errors. The typographical errors are corrected by the present amendments.

Claim Rejections Under 35 U.S.C. §103

The Examiner rejected Claims 1, 3, 8-17, 28, 30 and 32 under 35 U.S.C. §103 as obvious over the combination of U.S. Patent Application No. 2002/0027286 to Sundararajan and U.S. Patent No. 6,006,763 to Mori. In particular, the Examiner found that Sundararajan teaches forming a copper oxide by CMP and reducing the copper oxide by using plasma. Mori was found to teach a method of surface treatment wherein metal oxide is reduced using an organic reducing agent.

With respect to Claim 1 and 28, the Examiner concluded that it would have been obvious to reduce the copper oxide of Sundararajan as taught by Mori because "Mori recognizes that metal oxides can be reduced to metals using organic material."

Mori teaches a reducing agent that is formed by ionizing a gas. While the gas may comprise an organic compound, Mori teaches that it is the activated gas that is used as the reducing agent. Mori does not teach or suggest that the gas could act as a reducing agent if it were not activated.

Claim 1 has been amended to clarify that the claimed process reduces oxide "by exposure" to an organic reducing agent that is a *stable* molecule. In contrast, the organic reducing agent taught by Mori is an activated species and is not a stable molecule. Because Mori does not teach or suggest that a stable organic molecule can act as a reducing agent, the claimed process would not be obvious to the skilled artisan in view of the teachings of Mori.

The skilled artisan will recognize that there is a chance that a small portion of the gas comprising an organic compound will not be ionized in the process described by Mori. Nevertheless, the process described by Mori reduces "by exposure" to activated species. Further, Mori does not teach or suggest that a stable organic reducing agent would be effective in reducing the metal oxide. The process of Claim 1 is clearly directed to the use of stable molecules. Thus, it would not be obvious in view of the teachings of Mori.

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The deficiencies of Mori are not made up for by the teachings of Sundararajan. As the Examiner recognized, Sundararajan indicates that copper oxide is typically reduced by plasma reduction. As there is no teaching or suggestion of reducing copper oxide with a stable organic reducing agent in Sundararajan or Mori, Applicants respectfully request that the present rejection of Claim 1 be withdrawn.

Claim 28 has been amended herein to incorporate Claim 29 and to indicate that the organic reducing agents are in the vapor phase. Neither Sundararajan nor Mori teach or suggest that the organic reducing agent comprises at least one functional group selected from the group consisting of alcohol, aldehyde and carboxylic acid.

The Examiner cites Nishikawa (U.S. Patent No. 5,865,365) for teaching the use of aldehydes, alcohols and carboxylic acids to reduce metal oxides. Nishikawa teaches the use of organic material in the liquid state (see, for example, column 4, lines 29-31 and column 5, lines 15-16) and does not teach or suggest the use of vapor phase organic reducing agents. Thus, Applicants submit that Nishikawa does not make up for the deficiencies of Sundararajan and Mori.

As the remaining claims depend from Claim 1 or Claim 28 Applicants submit that in view of the arguments presented above, all claims are allowable.

Conclusion

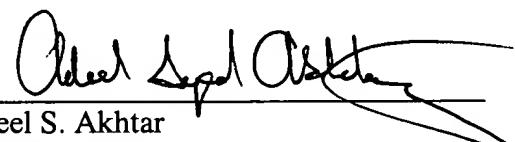
In view of the present amendments and arguments, Applicant submits that the application is in condition for allowance and respectfully requests the same. If, however, some issues remain the Examiner is cordially invited to call Applicant's counsel at the number listed below in order to resolve such issues promptly.

Respectfully submitted,

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Version with Markings to Show Changes Made

Claims 1, 5, 8 and 28 have been amended as follows:

1. (Amended) A process for producing an integrated circuit comprising reducing copper oxide on a substrate by exposure to one or more stable organic reducing agents prior to deposition of a layer comprising silicon carbide.

5. (Amended) The process of Claim 4, wherein the organic reducing agent is selected from the group consisting of primary alcohols, secondary alcohols, tertiary alcohols, polyhydroxyalcohols, cyclic alcohols, and halogenated alcohols.

8. (Amended) The process of Claim 1, wherein said copper oxide is present after a chemical mechanical polishing (CMP) step.

28. (Amended) A process for producing an integrated circuit comprising the following steps, in order:

depositing a copper layer on a substrate;

subjecting the copper layer to a CMP process;

contacting the substrate with one or more vapor phase organic reducing agents; and

depositing an etch stop layer on the substrate, wherein the organic reducing agents comprise at least one functional group selected from the group consisting of alcohol (-OH), aldehyde (-CHO), and carboxylic acid (-COOH).